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ABSTRACT

This document describes the Conceptual Learning and Development (CLD) model of concept formation. According to the CLD analysis, a single concept is learned in the following successive levels of attainment: concrete, identity, classification, and formal. The four levels are considered applicable to concepts that are defined (or could be defined) in terms of attributes and have actual perceptible examples. CLD breaks down the ways in which concepts can be extended and used at each level, as well as the operations involved in concept learning at each level. Acquisition and remembering of names of concepts may come at any one of the levels and is only essential for formal conceptualization. This overview focuses on developmental aspects of the model, particularly certain predictions which will be empirically tested. These involve; (1) age influences on level of attainment and ways in which concepts are used, (2) individual differences, (3) invariant sequences through all applicable concepts, and (4) relationships between having labels for the concept and attainment of levels as well as mastery of its uses. The conditions of learning for each level are categorized into internal (discussed in terms of operations and attainment at the preceding level) and external (concerned with task and instructional variables that facilitate learning) factors. Finally, a discussion of relationships between CLD and other viewpoints is included. (DP)

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Overview of a Model of Conceptual Learning and Development[1, 2]

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Two kinds of research on concept learning have been carried out during the past decades. One type of research is concerned with clarifying the internal and external conditions of concept learning; another type of research involves the behavioral analysis of concept learning tasks related to various subject-matter fields. Sufficient knowledge has accrued from this research to formulate a model of conceptual learning and development (CLD model). The CLD model was first reported in a short article by Klausmeier (1971) and subsequently in a book by Klausmeier, Ghatala, and Frayer (in press).

In the CLD model, the word "concept" is used to designate both mental constructs of individuals and also identifiable public entities that comprise part of the substance of the various disciplines. The word "concept" is defined as ordered information about the properties of one or more things--objects, events, or processes--that enables any particular thing or class of things to be differentiated from and also related to other things or classes of things.

In connection with concepts as mental constructs it is noted that each maturing individual attains concepts according to his unique learning experiences and maturational pattern. In turn, the concepts he attains are used in his thinking about the physical and social world. The role of concepts in explanations of thinking is well-stated by Kagan (1966):

> . . . concepts are the fundamental agents of intellectual work. The theoretical significance of cognitive concepts (or, if you wish, symbolic mediators) in psychological theory parallels the

> seminal role of valence in chemistry, gene in biology, or energy in physics. Concepts are viewed as the distillate of sensory experience and the vital link between external inputs and overt behaviors. The S-O-R model of a generation ago regarded O as the black box switch that connected behavior with a stimulus source. The O is viewed today as a set of concepts or mediators (Kagan, 1966, p. 97).

Concepts as public entities are defined as the organized information corresponding to the meanings of words. These meanings are put into dictionaries, encyclopedias, and other books. Thus, the meanings of the words comprise the societally accepted, or public, concepts of groups of persons who speak the same language. Carroll (1964) related concepts, words, and word meanings this way. Words in a language can be thought of as a series of spoken or written entities. There are meanings for words that can be considered a standard of communicative behavior that is shared by those who speak a language. Finally, there are concepts, that is, the classes of experiences formed in individuals either independently of language processes or in close dependence on language processes. Putting the three together, Carroll states: "A meaning of a word is, therefore, a societally standardized concept, and when we say that a word stands for or names a concept it is understood that we are speaking of concepts that are shared among members of a speech community" (Carroll, 1964, p. 187).

Features of the CLD Model

Figure 1 shows the structure of the CLD model. Four levels in the attainment of the same concept at successively higher levels are outlined. The four successive levels are concrete, identity, classificatory, and formal.

A second part of Figure 1 shows the ways that concepts may be extended and used. Concepts acquired at the classificatory and formal levels may be generalized to newly encountered instances, related to other concepts,

and used in problem-solving situations. Here we are concerned both with transfer of learning and the use of concepts in thinking.

Third, Figure 1 indicates the operations involved in attaining a concept at each level. Attending to and discriminating objects and then remembering what was discriminated are involved in attaining the concrete level. The same operations are also involved at each subsequent level and are supplemented with the higher-level operations of generalizing, hypothesizing, and evaluating. In this connection, concept attainment at the concrete and identity levels is treated by some psychologists as discrimination learning (Gagné, 1970). More important than what this form of learning is called is the matter of the invariant sequence in which the four levels are attained.

The fourth part of the CLD model shows that acquiring and remembering the names of the concepts may come at any of the four levels. The solid line indicates that having the name of the concept and the names of attributes is essential to attaining concepts at the formal level. The broken lines indicate that an individual may acquire the name at about the same time he first attains the concept at lower levels but that this is not requisite. For example, a young child might attain a concept at all three lower levels but not have the concept name. The younger the child is upon attaining the concept, the less likely he is to have the name for it.

From this brief overview it may be inferred that the CLD model in its entirety describes the attainment of four levels of the same concept and uses of the concept rather than four different kinds of concepts. The four levels are presumed to be applicable to the many concepts that are defined, or can be defined, in terms of attributes and which have actual perceptible examples or readily constructed representations of examples. There are other kinds of concepts that either do not have the examples, or

they are not defined in terms of attributes, or both. Various parts of the CLD model are applicable to these concepts, rather than the model in its entirety (Klausmeier, Ghatala, & Frayer, in press).

Predictions Based on the CLD Model

The CLD model may be understood more fully in terms of predictions regarding the course of conceptual development based on it, its specifications of the internal conditions of learning at each of the four levels of attainment, and its implications for specifying the external conditions of learning. The main purpose of this paper is to deal with the developmental aspects of the CLD model.

The implications of the CLD model for understanding the course of conceptual development may not be immediately apparent. Six predictions following from the CLD model will clarify its potential contributions regarding conceptual development. First, a higher percentage of children at any particular age will attain mastery of the four successive levels. For example, a higher percentage of the ten-year-olds, in comparison with eight-year-olds, will master the classificatory level. This prediction, however, does not imply that the amount of change in the attainment of the various levels will be greater, lesser, or the same for any particular years. For example, a sharper change in the attainment of concepts at the formal level may or may not occur between ages eleven and twelve in comparison with between ages twelve and thirteen. (Age is used as a shorthand term to indicate the product of learning and maturation; age, per se, is not considered a determining factor of how well individuals can perform.)

The second prediction deals with the invariant sequence in the attainment of the successive levels of a concept. According to the CLD model,

each successive level of concept attainment involves at least one new cognitive operation that emerges with learning and maturation. In turn, the individual cannot attain any particular level until he has the capability for carrying out the new and more complex operation. Therefore, only five patterns of attaining (A) and not attaining (N) the four successive levels are consistent with the CLD model as follows: Not attaining any of the four levels (NNNN), attaining the concrete level and not attaining the next three levels (ANNN), attaining the concrete and identity levels and not attaining the classificatory and formal levels (AANN), attaining the first three levels and not attaining the formal level (AAAN), and attaining all four levels (AAAA). There are 11 patterns of attaining and not attaining the various levels that are inconsistent with the CLD model.

To reiterate, the prediction is that the same sequence of attainment is common to all concepts that may be defined in terms of attributes and for which numerous examples or representations of examples are experienced by individuals, starting in early childhood. At the same time, the CLD model does not imply that a child will attain a particular level of different concepts during the same year; for example, a child may reach the classificatory level of cutting tool but not of concrete noun during the sixth year of life.

These two predictions just discussed deal with the levels of attainment. Two predictions related to the uses can also be made. The first is that mastery of the various uses will increase with age. For example, a higher percentage of ten-year-olds, in comparison with eight-year-olds, will use their concept of equilateral triangle in understanding principles involving the concept of equilateral triangle.

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A second prediction pertaining to uses is that a higher percentage of those who have attained the formal level, in comparison with those who have attained only the classificatory level, will correctly perform each use of the concept. A related prediction is that those who have attained only the two lower levels will not be able to use the concept in understanding principles involving the concept or in understanding supraordinate-subordinate relationships between the particular concept and other concepts of a taxonomy. In other words, a concept must be attained at least to the classificatory level before it can be used in understanding a principle involving the concept or in understanding relationships between the particular concept and other concepts of a taxonomy. It is noted that a concept attained at only the concrete or identity level may be used in solving simple problems. This is presumed to be the case when the problem can be solved by relating and acting on immediate perceptions. For example, a young child may get on the opposite end of a see-saw from another child when asked "Where should you sit to start the see-saw?" even though he has not attained the concepts of equality, weight, or distance at the classificatory level.

The preceding predictions, except the one dealing with the invariant sequence in attaining successive levels of the same concept, are stated in terms of normative behaviors of children at various chronological ages. Another prediction is in order concerning individual differences among children of the same chronological age. At any particular year of age wide differences among children will be found with respect to the level at which they have attained any particular concept and also at which they have mastered the uses of the concept. It may be appropriate to digress briefly and indicate that it is further predicted that, within limits, instruction can be arranged to get a child to attain any particular level at an earlier age than most

children currently do and also that unless instruction is provided some children will never attain the formal level of many concepts. At present, two kinds of longitudinal studies are underway dealing with these predictions and also the earlier ones. One study is descriptive; about 100 children of each of four age levels in two different school systems are participating; the other is an intervention study (Hooper & Klausmeier, 1973).

A sixth and final major prediction is that having the labels for the concept and its attributes will be positively correlated with attainment of the levels and mastery of the uses. For example, attainment of the four levels and mastery of the uses of the concept, equilateral triangle, will be facilitated by having the labels for the concept, equilateral triangle, and also the labels for its defining attributes--three equal sides, three equal angles, plane figure, simple figure, and closed figure. The CLD model indicates directly that having the preceding labels is essential for attainment at the formal level. This prediction indicates that having relevant vocabulary will be positively correlated with the attainment at all levels and with the uses of the concept. It is further predicted that mastery of the vocabulary will not be as closely related to concept attainment at the concrete and identity levels as to attainment at the higher levels and mastery of the uses.

The preceding predictions deal primarily with the developmental aspects of the CLD model. The CLD model also specifies directly the internal conditions of learning associated with each level, and many of the external conditions of concept attainment at each level can be described.

The internal conditions essential to the attainment of a concept at any of the four levels are indicated in Figure 1 and are stated in terms of operations and attainment of the concept at the preceding level. For

example, to attain a concept at the identity level, the individual must be capable of the following: attending to the concept example, discriminating it from nonexamples, remembering it, and generalizing that the example is the same thing when perceived from a different spatio-temporal perspective or sensed in a different modality. Further, the individual must already have attained the concept at the concrete level or be capable of doing so.

In connection with the external conditions of learning at each level, substantial evidence is available to indicate that several sets of powerful variables at the classificatory and formal levels can be dealt with in instructional materials to facilitate attainment (Klausmeier, Ghatala, & Frayer, in press). They are variables associated with the concept itself; the concept definition; the number, proportion, and sequencing of examples and nonexamples of the concept; cueing related to the attributes of the concept; and feedback (Feldman, 1972; Frayer, 1970; Nelson, 1971; and Swanson, 1972). Guidelines that take into account knowledge regarding these variables have been formulated for developing instructional materials and are currently in the process of refinement and validation (Klausmeier, Ghatala, & Frayer, in press).

Relationships with Other Viewpoints

From the preceding brief description of the structure of the CLD model and the related predictions, a few relationships to other viewpoints about conceptual learning and development and also about instruction may be observed. That part of the CLD model which deals with concept learning over short time intervals bears some similarity to theories of concept learning generated by American experimental psychologists and reviewed by Bourne, Ekstrand, and Dominowski (1971): theory of associations (Bourne & Restle, 1959), theory

of hypotheses (Levine, 1966; Trabasso & Bower, 1968), theory of mediation (Osgood, 1953), and theory of information processing (Hunt, 1962). It is most similar to Hunt's theory in that both incorporate information-processing constructs. Both the CLD model and the preceding theories imply that all the concepts held by any individual are learned; they do not emerge simply with maturation. Thus there is agreement with other American theorists that the attainment of concepts is explainable in terms of principles of learning. The CLD model differs from the four theories just mentioned in one very important way. It describes four different and successively higher levels in the attainment of the same concept and also specifies the cognitive operations involved in the attainment of the same concept at each level. Some operations are postulated to be common to all four levels of concept attainment. This specification of four successive levels, each of which must be attained before the next one, bears some resemblance to Gagné's (1968) formulations concerning a learning hierarchy and also to his notions about the successive kinds or forms of learning, starting with S-R connections and extending through problem-solving (Gagné, 1970).

That part of the CLD model dealing with the attainment of the same concept at successively higher levels bears some resemblance to Piaget's (1970) description of conceptual development in that an organism-centered interactional viewpoint toward learning and development is accepted. Also, qualitative differences in the performances of individuals at successive levels of concept attainment are postulated, and these differences are presumed not to be merely additive. Different from Piaget, no attempt is made to explain the biological or physiological bases of learning concepts across long time intervals and a neutral position is maintained with respect to global operations such as equilibration, assimilation, and accommodation.

On other important matters the CLD model implies greater emphasis than Piaget gives to the conditions of learning over short time intervals, to continuity and gradualness rather than discrete stages in conceptual development, to learning-environmental factors rather than biological-genetic factors in the emergence of cognitive operations, and to internalized verbal and nonverbal representation of experiences rather than logico-mathematical structures. Though not dealing directly with the biological or physiological bases of concept learning, the CLD model presumes that human beings have certain genetically determined abilities that emerge as the individual matures and interacts with a physical and social environment and that these abilities make concept attainment possible. Just as the individual's speech emerges with learning within broad genetically determined limits, so also do the various cognitive operations specified in the model. However, the higher levels of concept attainment and the related operations are presumed to be more intimately related to directed experiences, or guided learning, than are some other abilities such as prehensile grasping, upright walking, and speech.

In this brief overview, I have indicated the essential features of the CLD model, cited its origin in laboratory and school experimentation, related it to a few other viewpoints, and cited sources of additional information. I would indicate that one cross-sectional study has been reported that supports the various predictions (Klausmeier, Ghatala, & Frayer, in press). The next participants in this symposium will deal with the predictions and the various elements of the CLD model in more detail.

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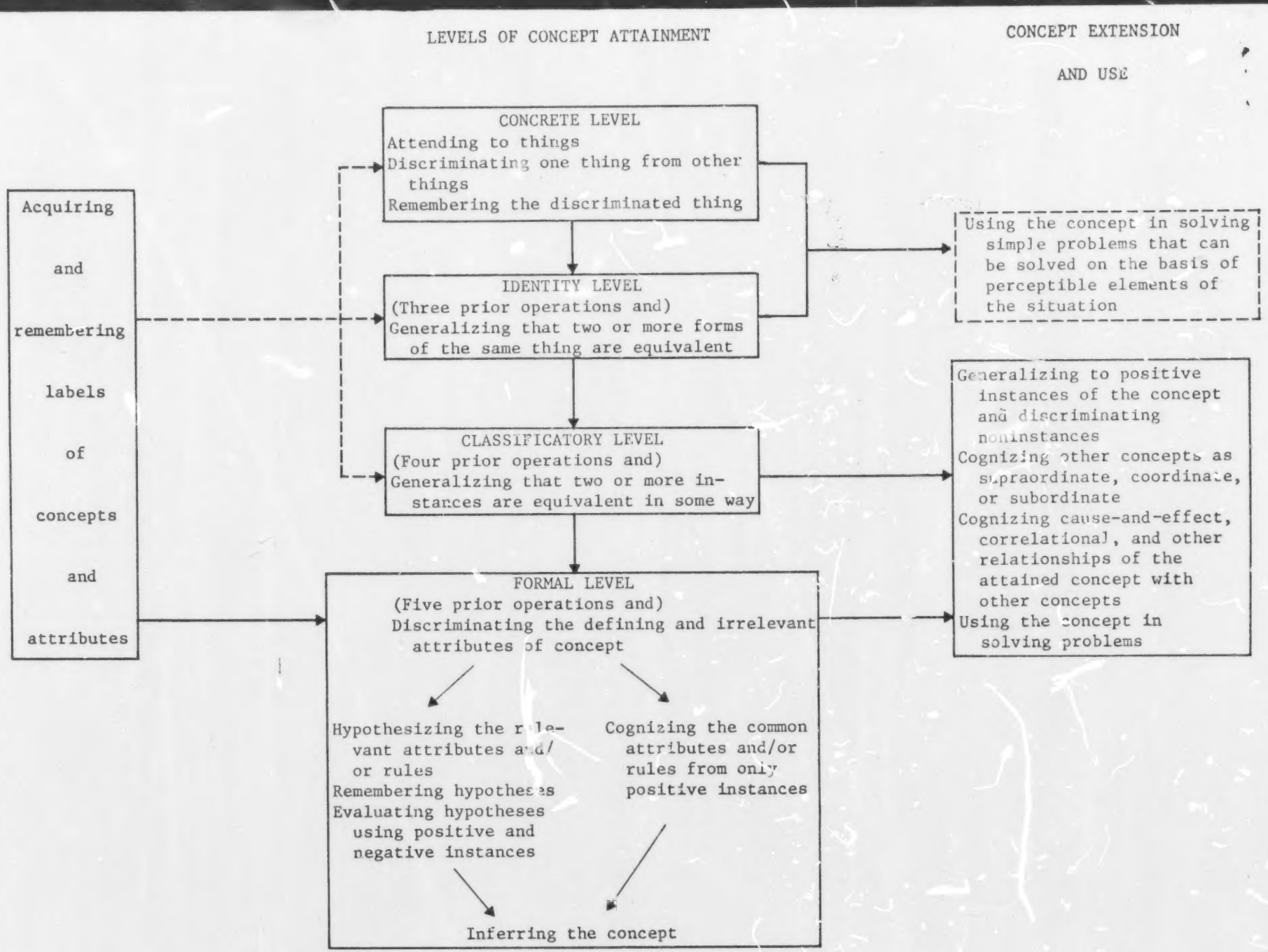
LEVELS OF CONCEPT ATTAINMENT
CONCEPT EXTENSION AND USE
Acquiring and remembering labels of concepts and attributes
CONCRETE LEVEL
Attending to things
Discriminating one thing from other things
Remembering the discriminated thing
IDENTITY LEVEL
(Three prior operations and)
Generalizing that two or more forms of the same thing are equivalent
CLASSIFICATORY LEVEL
(Four prior operations and)
Generalizing that two or more instances are equivalent in some way
FORMAL LEVEL
(Five prior operations and)
Discriminating the defining and irrelevant attributes of concept
Hypothesizing the relevant attributes and/or rules
Remembering hypotheses
Evaluating hypotheses using positive and negative instances
Cognizing the common attributes and/or rules from only positive instances
Inferring the concept
Using the concept in solving simple problems that can be solved on the basis of perceptible elements of the situation
Generalizing to positive instances of the concept and discriminating noninstances
Cognizing other concepts as supraordinate, coordinate, or subordinate
Cognizing cause-and-effect, correlational, and other relationships of the attained concept with other concepts
Using the concept in solving problems

Figure 1. Cognitive operations in concept learning.